T 90: Muon detectors

Time: Thursday 16:00–18:35 Location: To

Group Report T 90.1 Thu 16:00 To

Commissioning of the new small-diameter Monitored Drift Tube detectors for the Phase-1 Upgrade of the ATLAS muon spectrometer — •Elena Voevodina, Gregor Hieronymus Eberwein, Oliver Kortner, Hubert Kroha, Daniel Soyk, Patrick Rieck, and Marian Rendel — Max Planck Institute for Physics, Munich, Germany

The Muon Drift Tube chambers provide very precise and reliable muon tracking and momentum measurement in the ATLAS muon spectrometer. Already in Run 2 of the LHC they have to cope with very high background counting rates up to 500 Hz/cm2 in the inner endcap layers. At High-Luminosity LHC, the background rates are expected to increase by almost a factor of 10. New small (15 mm)-diameter Muon Drift Tube detectors have been developed for upgrades of the muon system. They provide about an order of magnitude higher rate capability and allow for the installation of additional new triplet-RPC trigger chambers in the barrel inner layer of the muon detector for HL-LHC. A pilot project for the barrel inner layer upgrade is underway during the 2019/21 LHC shutdown. Several sMDT chambers have already been installed and operated in the ATLAS detector. The detailed studies of the muon detection efficiency and muon track resolution have been carried out after the assembling of the sMDT detectors in MPI and repeated at CERN after the integration with the new RPC detectors. The author will describe the detector design, the quality assurance and certification path, as well as will present the status of sMDT detectors installation and commissioning in the ATLAS experiment.

T 90.2 Thu 16:20 To

CMS Drift Tube Chambers : Upgrade activities during LHC long shutdown II — •Archana Sharma, Thomas Hebbeker, Kerstin Hoepfner, Hans Reithler, and Saranya Ghosh — III. Physikalisches Institut A, RWTH Aachen Universtity

To sustain and extend its discovery potential, the Large Hadron Collider (LHC) will undergo a major upgrade in the coming years, referred to as High Luminosity LHC (HL-LHC), aimed to increase its instantaneous and integrated luminosity respectively by a factor of five and ten beyond the original design value. After delivering an integrated luminosity of more than 160 fb-1 until the end of Run 2, at the beginning of 2019, LHC has been shutdown for two years (LS2) in order to get its accelerator-chain and detectors upgraded for the HL-LHC phase. During this LS2, the CMS experiment aims to upgrade its electronics and detector performance to improve the data taking and a precise reconstruction of all the particles in high pile-up conditions of HL-LHC. The Drift Tube (DT) chambers are one of the important parts of the CMS muon system responsible for identifying, measuring and triggering on muons by the precise measurement of their position. This talk summarises the ongoing activities and plans related to the upgrade activities of the DT chambers.

T 90.3 Thu 16:35 To

Performance of Muon Drift Tube Detectors and Fast Readout Electronics at Very High Counting Rates — Hubert Kroha, Oliver Kortner, Elena Voevodina, and •Gregor Eberwein — Max-Planck-Institute for Physics, Munich, Germany

Small-diameter Drift Tube (sMDT) detectors with 15 mm tube diameter have proven to be excellent candidates for precision muon tracking detectors in experiments at future hadron colliders like HL-LHC and FCC-hh where unprecedented high background rate capabilities are required. sMDT chambers are currently being installed in the inner barrel layer of the ATLAS muon spectrometer. The rate capability of the sMDT drift tubes in terms of muon detection efficiency and spatial resolution is limited by the performance of the readout electronics. Simulations show, that the addition of active baseline restoration circuits in the front-end electronics chips in order to suppress signal-pile-up effects at high counting rates leads to significant improvement of both efficiency and resolution. To confirm these expectations, extensive tests using sMDT prototype chambers have been conducted at the CERN Gamma Irradiation Facility. Chambers equipped with readout chips with improved pulse shaping and discrete readout circuits with baseline restoring functionality have been tested. Results of both simulation and test will be presented. They provide guidelines for the design of a new sMDT readout chip for operation at very high counting rates.

T 90.4 Thu 16:50 To

The CMS Muon upgrade and the impact of GEM etching techniques on detector performance — •Francesco Ivone, Thomas Hebbeker, Kerstin Hoepfner, Henning Keller, Giovanni Mocellin, and Shawn Zaleski — III. Physikalisches Institut A, RWTH Aachen University

The LHC will undergo a major upgrade to deliver ten times more pp-collisions in the next two decades, which has been named High-Luminosity LHC (HL-LHC). To cope with the higher event rates and with the increased radiation doses, the Compact Muon Solenoid (CMS) experiment will undergo several upgrades including the installation of an additional set of muon detectors based on the Gas Electron Multipliers (GEM) technology. Triple-GEM detectors have already been installed in the CMS endcap stations named GE1/1 during Long Shutdown 2, while two more stations, GE2/1 and GE0, will adopt the same technology during subsequent shutdowns. The GEM foils, the core of GEM-based detectors, are currently produced with either double-mask or single-mask etching. Despite being an effective method, GEM hole asymmetry is observed in single mask compared to double mask. The effect of the hole asymmetry on the detector performance has been studied with a twofold approach. On one hand experimental data have been collected using GEM foils with different hole geometries, on the other hand detailed simulations have been performed matching the experimental set-up conditions. This talk gives an introduction to GEM detectors in CMS and describes a study to assess the impact of the GEM hole asymmetry on the detector performance.

T 90.5 Thu 17:05 To

Muon reconstruction efficiency evaluation with the ATLAS detector at the LHC using J/ψ and Υ resonances — •Noemi Cavalli — INFN and Università di Bologna, Italy - TU Dortmund, Germany

This work is carried out within the Muon Combined Performance group of the ATLAS Experiment at the LHC. Muon reconstruction efficiencies are measured using data collected by the detector. $J/\psi \longrightarrow \mu\mu$ events are employed and the "Tag and Probe method" is used. The ratio between the reconstruction efficiency obtained from the data and from simulated J/ψ samples is then evaluated. This ratio is called "Scale Factor" and it is provided to the ATLAS Collaboration to correct simulated muon samples employed in physics analyses. In particular, the Scale Factor systematic uncertainty associated to the fit model choice has been improved by using Monte Carlo samples with real background events injected on the simulated samples to test the fit performance.

In the second part of the work the reconstruction efficiency and Scale Factor evaluation has been extended to $\Upsilon \longrightarrow \mu\mu$ events. The Υ resonance has never been exploited by the ATLAS Collaboration to get muon reconstruction efficiencies and its implementation would be complementary to the other standard candles used so far. A dedicated strategy for Υ events has been developed, starting from the one employed for the J/ψ meson. The state of the art and the outlook on future developments is presented.

T 90.6 Thu 17:20 To

Trigger Performance Studies with a small-strip Thin Gap Chamber quadruplet — •Ksenia Solovieva, Jose Antonio Fernandez Pretel, Vladislavs Plesanovs, Patrick Scholer, and Ulrich Landgraf — Albert-Ludwigs University, Freiburg, Germany

The ongoing ATLAS detector upgrade includes the implementation of the New Small Wheels as part of the Muon Spectrometer. One of its detector technologies is the small-strip Thin Gap Chamber (sTGC), used for improved triggering and tracking in a higher particle rate environment. The sTGC detector readout is segmented into strips and pads, which play a key role in the trigger chain. For the purpose of investigating the sTGC pad trigger performance, a quadruplet was set up in a cosmic muon test stand in Freiburg and read out with the final ATLAS NSW readout system. This presentation discusses the goals and challenges of the setup, as well as presenting the prospective results of the trigger studies.

T 90.7 Thu 17:35 To

Alignment reconstruction of Micromegas quadruplets — •Fabian Vogel, Otmar Biebel, Maximilian Herrmann, Ralf Hertenberger, Christoph Jagfeld, Felix Klitzner, Katrin Penski, Maximilian Rinnagel, and Chrysostomos Valderanis — LMU München

For the upcoming New Small Wheel upgrade of the ATLAS detector Micromegas quadruplets will be implemented as muon tracking detectors. These gaseous detectors are optimized for the detection of minimum ionizing particles. They contain a metallic micromesh to divide the gas volume into a drift and an amplification region. The anode on the bottom of the detector contains parallel readout strips on a printed circuit board (PCB) for one dimensional readout. Each of the four detector layers is built from three individual PCBs glued side-by-side on either side of the readout panel. The alignment of a quadruplet made from two readout panels with four layers of PCBs, for each individual layer, as well as the alignment of these layers with respect to each other is investigated. Studies of those quadruplets in the cosmic ray facility of the LMU are compared to optical precision inspections using dedicated markers on the PCBs. New measuring techniques have been developed and integrated in the series production of the modules. Results of the comparison will be presented.

T 90.8 Thu 17:50 To

Construction of new small-diameter Monitored Drift Tube (sMDT) chambers for the HL-LHC upgrade of the ATLAS Muonspectrometer — •Marian Rendel, Patrick Rieck, Verena Walbrecht, Oliver Kortner, and Hubert Kroha — Max-Planck-Institut für Physik (Werner-Heisenberg-Institut), München

In order to improve the muon trigger efficiency of the ATLAS muon spectrometer for the high luminosity upgrade of the Large Hadron Collider (HL-LHC), the precision tracking Monitored Drift Tube (MDT) chambers in the inner barrel layer will be replaced by integrated stations combining new thin-gap RPC trigger chambers with new small-diameter Monitored Drift Tube (sMDT) chambers. The sMDT chambers are designed to meet the very tight space constraints in the detector and to provide an order of magnitude higher background rate capability compared to the current detectors.

The sMDT chambers have to provide a sense wire positioning accuracy of better than 20 μm. The assembly procedures and the results of the measurements of the geometry of prototype chambers and of the first chambers of the serial production are discussed.

T 90.9 Thu 18:05 To

Construction of new small diameter Monitored Drift Tube (sMDT) chambers for the ATLAS muon spectrometer at the HL-LHC — •Verena Walbrecht, Marian Rendel, Patrick Rieck, Oliver Kortner, Sandra Kortner, and Hubert Kroha — Max-Planck-Institut für Physik

In order to improve the muon trigger efficiency of the ATLAS muon spectrometer for the high-luminosity upgrade of the Large Hadron Collider (HL-LHC), the precision tracking Monitored Drift Tube (MDT) chambers in the inner barrel layer will be replaced by integrated stations combining new thin-gap RPC trigger chambers with new small-diameter Monitored Drift Tube (sMDT) chambers. The sMDT chambers are designed to meet the very tight space constraints in the detector and to provide an order of magnitude higher background rate capability compared to the current detectors.

In this talk, the results of measurements of the geometry, the tests, and the performance of the chambers are discussed.

T 90.10 Thu 18:20 To

Development of a tester hardware tool for new-read electronic cards of the MDT detectors of the ATLAS muon spectrometer for the Phase-II upgrade — •Mathias Modlmayr, Gia Khoriauli, and Raimund Ströhmer — University of Würzburg

The monitored drift tube detectors (MDT) are part of the ATLAS muon spectrometer. The MDT segments (chambers) are read-out with on-chamber mezzanine cards. The cards are equipped with signal amplifier-shaper-discriminator and time to digital converter chips. For the LHC Phase-II upgrade, these cards are planned to be replaced with the new mezzanine cards currently being developed. The new MDT read-out is essential to cope with the increased particle rates at the High-Luminosity LHC. Moreover, the MDT will be part of the ATLAS hardware-based trigger system. Therefore, one of the new requirements to the new mezzanine cards is to operate in a triggerless read-out mode as well as to keep a triggered read-out mode as an option.

We develop a hardware tool, which will be used in the quality mass tests of the new mezzanine cards. The main goal of the tool is to test all functionalities and the stability of the new mezzanine cards and certify them. Also, efficiencies, noise rates, crosstalk, resolution and linearity of time measurements and some more characteristics of the mezzanine cards will be measured and documented in a dedicated database. The current status of the development of the tester tool and the test procedures are presented.